

**The National Space Grant Office requires two annual reports, the Annual Performance Data Report (APD – this document) and the Office of Education Performance Measurement System (OEPM) report. The former is primarily narrative and the latter data intensive. Because the reporting timeline cycles are different, data in the two reports may not necessarily agree at the time of report submission. OEPM data are used for official reporting.**

## **Rhode Island Space Grant Consortium**

**Lead Institution: Brown University**

**Director: Peter H. Schultz**

**Telephone Number: 401-863-1151 (RISG Office)**

**Consortium URL: <http://www.brown.edu/initiatives/ri-space-grant/>**

**Grant Number: NNX10AI95H**

### **PROGRAM DESCRIPTION**

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The Rhode Island Space Grant Consortium is a Program Consortium funded at the base level of \$430,000 for fiscal year 2014.

### **PROGRAM GOALS**

**Outcome 1:** (1) Engage, inspire, and motivate graduate and undergraduate students in the process of research and discovery. (2) Engage these students to public involvement in NASA's themes and missions in order to develop a sustained commitment to sharing NASA's research with their stakeholders. (3) Develop and sustain future research programs through graduate support. (4) Encourage research that can be integrated into training students and develop new directions and opportunities relevant to NASA's goals and missions. (5) Increase students in STEM fields through (a) postsecondary curricula, (b) meaningful hands-on experiences, and (c) increase involvement of women and under-represented and underserved groups in STEM careers. **Outcome 2:** (1) Inspire and motivate educators to incorporate aerospace themes into their classrooms; (2) Engage undergraduates and graduate students in formal and informal education in order sustain their future involvement, whether as faculty researchers or educators; and (3) Engage graduate students in the excitement of their research through communicating their NASA-related results. **Outcome 3:** To inspire, engage, promote, and educate the public in NASA's mission through informal education at museums and other resources.

## PROGRAM/PROJECT BENEFIT TO OUTCOME (1,2, and 3)

**International Genetically Engineered Machine (iGEM) Competition:** During the summer of 2014, the *Stanford-Brown-Spelman iGEM* team had the unique opportunity to collaborate with NASA Ames Research Center in order to conduct novel research utilizing the burgeoning field of synthetic biology to design microorganisms to aid with an area of NASA previously untouched by synthetic biology: unmanned aerial vehicles (UAVs.) *iGEM* (international Genetically Engineered Machine competition) is the premiere synthetic biology competition in the world, gathering 245 schools from six continents to compete in areas of design, construction and research within the field of synthetic biology. Synthetic biology uses engineering principles and design concepts within the life sciences. In *iGEM*, students used standardized, functional sequences of DNA called 'Biobrick' parts that enabled synthetic biologists to engineer different biological systems using interchangeable parts. Presentations were made to NASA's Chief Scientist, head of NASA-HQ's new Office of Chief Technologist and Space Technology, and NASA-ARC Director. The team once again earned a gold medal, and an honorable mention in the design category. This effort directly addressed all 3 Outcomes. Featured in national media (*The New Yorker*), web reports, and *Discovery Channel*.

## PROGRAM ACCOMPLISHMENTS

• **OUTCOME 1. SMART OBJECTIVES:** *Specific:* Awards based on the proposed research (including NASA relevance), grades, letters of recommendation, and prior responsiveness of their advisors (for repeat requests) with balance across departments, advisors, young faculty, gender, ethnicity, and relevance. *Measurable:* Metrics include student publications & presentations (abstracts, papers, poster presentations, presentations at annual symposia), and continued involvement with our (or other SG) program. *Acceptable:* All tied directly to NASA's strategic goals and objectives. *Realistic:* Awards governed by the ability for each university to identify a match through tuition awards or other means. *Time Frame:* Awards are for one year, hence spreading opportunity across the campuses & disciplines.

**A. FELLOWSHIP/SCHOLARSHIPS:** Awarded **18** Fellowship and Scholarship (not achieving 23 per year as proposed in our 5-Year target largely due to increased award costs). **3** graduate fellowships were awarded across consortium (both full year and summer), of which **2** were at the Lead and **1** at our Affiliate (URI). **5** competed undergraduate scholarships (**1**-Summer, **4**-RISG/UTRA awards) were awarded at the Lead. We also made **10** UG scholarships awards at our Affiliates. Finally, we made **5** targeted under-represented awards: **2** competed awards as part of our MSI programs, **1** award to our Tribal College initiative, and **2** awards to native American students.

**B. HIGHER EDUCATION (HE): SMART Objectives:** *Specific:* One-year awards based on clearly stated goals to develop, enhance, or integrate NASA-related programs into the undergraduate studies through new curricula, NASA competitions, or new approaches relevant to NASA. *Measurable:* Demonstrated student involvement, results (e.g., new/revised class) and connections with NASA Centers or programs. Projects (class or individual) are reviewed at the end of the award (e.g., critical design reviews, summaries) and presentations at the annual RI-SG Symposium. *Acceptable:* Selection requires that proposals document consistency with NASA themes/goals, hands-on

experiences, documented match, and potential for growth or self-sustainability. All travel grants have to demonstrate need (not just visits), specific goals, or participation (conferences or workshops). *Realistic*: We require that proposed efforts can be completed within the proposed budget. *Time Frame*: We make our awards for one year in order to engage more departments and faculty. All requests are necessarily tied to the academic calendar (not grant cycle).

**1. Course Development:** We proposed 4 new or revised NASA-related courses this year and met this target with 1 class at Affiliate RISD and 3 at Brown. **✪ *Design for Extreme Environments: Transcending Horizons*** (Rhode Island School of Design, *ID-24ST-07*): This Industrial Design class changes each year in response to a close collaboration between RISD and NASA personnel at NASA-JSC's *Habitability Design Center* (HDC). The majority of the semester was devoted designing modules for NASA's *Human Exploration Research Analogue* (HERA) and contributed to design for the *Crew Accommodation Module* (CAM). For the *HERA*, students designed a medical bay, a maintenance bay and a geology station (rack). Students were also selected to work as RISG/RISD interns at NASA JSC during the summer or winter sessions. One measure of success is the number of students invited back to JSC (or even hired). Two female students who participated in a RISD textiles course (reported in 2013) were invited back to JSC last summer to work with the *Softgoods Development & Testing Department*, e.g., to combine PBI and merino wool yarns into fabrics for astronaut uniforms. **✪ *Synthetic Biological Systems*** (Brown University, *BIOL 1210*): This multidisciplinary course provides students an integrated approach to the life sciences with innovative projects in order to build an understanding of the thought processes and tools necessary for cross-disciplinary work in the life sciences. It included fundamental principles of engineering such as abstraction, modularity, and standardization and how they are being applied to biology. Students in this class participated in the *iGEM* Competition. **✪ *Freshman Seminar*** (Brown University, *ENGN 0120*): This first-year seminar walks through the process of turning potential ideas into successful products. A critical point is the process called "crossing the chasm" where an idea must go beyond initial interest and gain the sort of traction that is required to become fully accepted by the marketplace, i.e., equivalent to a fully funded NASA mission. Space exploration and spacecraft design are recurring topics. **✪ *Senior Capstone*** (Brown University, *ENGN 1760*): This capstone course in spacecraft systems engineering focuses exclusively on the design of a complete spacecraft. In addition to lectures from Dr. Fleeter and other industry experts, student teams develop a spacecraft concept and build a working prototype to demonstrate a key aspect of their project. To a lesser extent, students develop a product definition in *ENGN 0120*, though typically they do not produce a physical working prototype.

**2. Undergraduate Engagement:** **✪ *RISG Graduate/Undergraduate Travel Grants***: Travel grants are extremely important for defining careers and are leveraged by departmental and institutional grants. Each award required written justification, NASA relevance, and evidence of active participation (presentations, posters, reports). We awarded 5 travel grants to undergraduate students for enabling or stimulating their research (part of *iGEM*). **✪ *NASA 2014 NASA Rover Challenge*** (RISD): Students at RISD have taken the challenge out of the classroom and into a club over the fall and during the Winter Break in order to meet the challenge. This has become a popular activity and challenges the students to meet new design requirements with innovative solutions.

This is the fourth entry into the competition and students and has become a popular draw and importance of design in enabling innovation for NASA. The Rover Team made presentations at local schools with a large under-represented population. ★ ***EquiSat*** (Brown): *EQUiSat* is an educational outreach mission at Brown University to build an open-source satellite and connect the public with space engineering. This year NASA's CubeSat Launch Initiative selected *EquiSat* for a launch in 2017. To reinforce a connection to space, *EQUiSat* will harbor a flashing high-power LED panel, thereby becoming the first CubeSat visible on the ground with the naked eye. Since the 2013, *EQUiSat* has progressed in technical design, outreach initiatives, and launch prospects. *EQUiSat*'s CSLI launch application was written and submitted at the end of 2013, and selected in February of 2014. All subsystems have advanced in design and engineering model construction. The launch application process has brought key technical reevaluations and new project deadlines. ★ ***Undergraduate Planetary Analog Field Trip*** (Brown): Over Spring Break, students from Geology participate in a heavily leveraged class trip to sites in the US that are relevant to understanding Earth Systems and planetary analogs. This year they traveled to Arizona (Meteor Crater, Grand Canyon, etc.). Each student wrote a summary about the trip and its impact on learning the role of NASA for terrestrial geologic processes. ★ ***Narragansett Native American Research Project***: We partnered with the URI/GSO and the Narragansett Indian Tribal Historic Preservation Office in order to provide 2 Narragansett tribal members the opportunity to engage in hands-on research dealing with possible ceremonial landscapes currently underwater. The project involved determining “best practices” methodology and state-of-the-art modeling approaches to predicting the locations of culturally sensitive sites on submerged and buried paleo-landscapes including the use of NASA tools and resources.

**3. Minority-Serving Institutions (MSI):** Rhode Island does not have a minority-serving institution of higher learning. Nevertheless, supported 3 different programs for MSI's. ★ ***RISG/Brown/Tougaloo Research Partnership***: RISG leveraged an existing program (bringing students from *Tougaloo* to Brown for summer classes) in order to introduce a *Tougaloo* student to research on the Brown campus over the summer. Selection was based on letters of recommendation, CV, and phone interview with a Brown faculty mentor. This year we supported a new student (computer science) along with a returning student from last year (at the request of the Brown mentor). ★ ***Tribal College Program***: Working with the *Associate Provost for Academic Development and Diversity*, we established a summer award for a student majoring in environmental science from *Salish Kootenai College*, Pablo Montana. With a mentor at Brown, she constructed a 3D printer and started making objects/landscapes with the ultimate objective to model the 2011 Missouri River flood on the Winnebago Reservation.

**C. RESEARCH INFRASTRUCTURE. SMART Objectives:** *Specific*: Awards for only one year and based on relevance to NASA themes and goals, budget, need, and absence of existing NASA funding for proposed tasks. *Measurable*: Increased involvement by faculty in NASA research programs, written summaries of outcomes, published results, involvement of graduate and undergraduates in NASA-related research, new proposals submitted to NASA, and/or papers presented at professional meetings-workshops or our annual symposium. *Acceptable*: Each award must demonstrate: relevance to NASA goals and objectives; their potential for seeding new grant opportunities; the involvement of new participants and students in the effort;

demonstration of a collaborative or cooperative interdisciplinary theme; and added merit if they can demonstrate collaboration with an existing NASA program or Center. *Realistic*: Ranked according to likelihood for results evidenced by a new proposal to NASA or graduate student after the award period. Our grants provide only seed funds (< \$10K). *Time Frame*: Limited to 1 year.

**1. Affiliate Faculty and Research Support:** Our specific goal each year is to enhance and deepen NASA-related research through small seed grants limited to <\$10K per investigator (excluding undergraduate research support) for 5 grants. We did not meet this goal, funding only 2 awards due to (1) new and expanded opportunities through NASA-EPSCoR; (2) difficulties related to administrative shifts in matching funds; and (3) revised commitments for other programs while being level funded. **★ Roger Williams University** (*Modified Galerkin Method to the Helmholtz equation for the SUPERELLIPSOID: Robin Condition*): Research testing the Robin boundary condition for the shape of the super-ellipsoid that could optimize the shape for the engine nacelles in order to reduce turbulence. **★ RISD: Partial Gravity Simulator:** Research on the a moderate-fidelity, low-cost, innovative method to simulate lower-than-earth gravity incorporating a simulated EVA suit, thereby allowing demonstrating living on low-gravity environments (Moon, Mars) for biomechanical studies and design.

**2. Lead Institution Faculty and Research Support:** Our annual objective was to support 2 seed grants and we met this goal. **★ Space Horizons 2014** (*McMurdo on the Moon*): RISGC & Brown University School of Engineering hosts a workshop focusing on new space technologies & concepts slightly over the horizon. It brings cross-disciplinary experts from industry, government, and universities (together with students) to discuss key questions and ways that emerging ideas might be brought into the main stream. This year, the workshop focused on the engineering of space infrastructure as a way to address the problem where space missions must bring along almost all resources. **★ Microgravity Effects on Cells:** A seed grant to evaluate the effect of microgravity on stem-cell viability and mobility using a bioreactor that simulates the effects of microgravity, thereby advancing the fields of space biology and regenerative medicine.

• **OUTCOME 2. SMART OBJECTIVES:** *Specific*: Support NASA-themed exhibits on space research; provide travel for informal, professional educators to NASA venues; and connect RISG participants with K12 teachers. *Measurable*: Educator responses to questionnaires, repeat participants, and solicited feedback on the use of material in the classroom; Documentation that materials have been implemented into workshops or programs at the museum; Assessment of student interactions based on 3 criteria (successful, moderately successful, and unsuccessful); *Acceptable*: Engage in hands-on professional development programming; focus on NASA themes and resources; and engage HE students with RI educators by incorporating their NASA research. *Realistic*: Engage at least 40 educators through our workshops or through other professional development. **Time Frame**: All activities are for one year.

**★ Educator Professional Development:** (a) *Museum of Natural History (MNH)*: 3 Educator workshops were planned at our Affiliate, the *MNH*, but only 2 were offered this year. (b) *Teacher Partnership Program*: Our 75:25 (75% Research to 25% Outreach) Program engages our RISG Fellows and Scholars through partnerships with RI K-12 teachers. Due to the reduction in fellowships at the Lead, we no longer can support this program. (c) *Brown Summer Academy*: We proposed to support 3 classes for middle and

high school students attending classes on campus, 2 given by RISG Summer Fellows. This strategy enhances the teaching skills of the graduate students. Only 1 class was offered last year. ☼ **Curricular Support Resources:** Our Affiliates (MNH) and Partners (Ladd Observatory and Planetary Data Center), *iGEM*, and *EquisSat* programs provide resources for students and mentoring through our outreach programs. We proposed to continue sharing research results and experiences with students through class visits, public speaking (e.g., local astronomy clubs), and special seminars. ☼ **Learning Community** (Central Falls, RI): This year we gave a one-year award to engage help sixth-graders (middle school) at a public charter school in a predominately under-served city in RI (~80% Hispanic, 18% African-American). The award taught students the basic computer applications and coding techniques. The goal is to develop a technology curriculum that can be replicated by other schools. This award helped to leverage an additional *Verizon Innovate Learning Grant* (for \$20K) for the school. ☼ **Student Involvement K-12:** The *MNH* provides most of this function for RISG. But other programs (*iGEM*, Rover Challenge, *EQUiSat*) engage students through presentations and hands-on involvement. ☼ **MNH Internship:** We provide support for an undergraduate to work with the MNH for exhibit development and programming related to NASA themes. ☼ **Krupowicz Planetarium:** The *MNH* Director developed new STEM-based (and NASA-themed) programs (Gaudet Middle School) and also supported 15 workshops for 75 educators. ☼ **Professional Development:** Travel for 2 MNH staff members to NASA Centers to allow developing new content for exhibits and enrich workshops.

• **OUTCOME 3. SMART OBJECTIVES:** *Specific:* (1) Support for the MNH (Providence). (a) Provide a new exhibit in the Space Room and continue development of a new exhibit about the Earth; (b) Work with our Partners to promote public events; (c) Promote NASA events through web and list-serve announcements. *Measurable:* Assess impact by through feedback forms, press coverage, and number of participants. And (c) Measure the distributed information through press announcements, TV announcements, web hits, and list-serves. *Appropriate:* Align All RI-SG sponsored exhibits, public events and open houses with NASA goals, missions, and themes. *Realistic:* Heavily leverage programs by partnerships with local museum. *Time Frame:* Offer new content on an annual basis but can extend in case of unusual circumstances.

The *MNH* reaches the entire southeastern New England and supports a large underserved population through the surrounding neighborhood, visitors, school excursions, and educator involvement. ☼ **Exhibits and Activities:** This year we focused our support on a new permanent exhibit about the Earth ("*Seismic Shifts*"), that included results of NASA research and instruments to illustrate how scientists monitor our changing planet, which had been delayed due to needed structural repairs. As a result, we did not change the *Space Room* exhibit this year as planned. ☼ **Attendance:** Museum attendance included 33,000 visitors and 8400 students in school groups for a total of 41,400 attendees last year (up 10%), in spite of the fact that one exhibit hall was closed for an extended period of time for repair and a new exhibit. These numbers exceed our objectives. ☼ **Full Dome:** RISG helped establish full-dome capability for the museum through leveraging. With full dome, the planetarium can be tied to the new Earth Room in addition to the space themes. ☼ **Engagement in RI Educational Programs:** The MNH Director (Renée Gamba) serves as *NASA Solar System Ambassadors* as well as a number of panels and committees (*Providence After School Alliance STEM Advisory Team*,

*Providence After School Alliance Experiential Learning Advisory Committee, Gaudet School STEM Team member and Middletown School Strategic Planning*). By serving on state-wide committees (such as the “*Science Curriculum Task Force*”, NASA-themes get into the classroom in meaningful and in sustainable ways. 🌟 **NASA Mission-related Outreach:** Through our partnership, exhibits at the *MNH* and the *NE Planetary Data Center*, we highlight NASA missions/instruments: *Cassini-Huygens*, *Stardust-NExT*, *Deep Impact*, *DIXI*, *Dawn*, *Curiosity*, *Rosetta*, and *GALEX*. These exhibits are more than display; they provide relevant objects and content for visiting educators, students, and the public. 🌟 **Krupowicz Planetarium:** This planetarium is on the other side of Narragansett Bay from the *MNH* and reached 2550 students and educators. Through RISG, the *MNH* Director partnered with this small planetarium at a middle school, which now functions as local resource that broadens the reach of NASA-related activities. Over the last year, this Planetarium hosted 5 *Family Fun Nights* reaching about 226 people. In February 2015, they held a “Galactic Explorer Day” an increase attendance by 5% from the prior year. 🌟 **Public presentations:** RI-SG faculty and students gave public presentations talks at local astronomy clubs and conventions. 🌟 **Museum Intern:** An undergraduate from Affiliate URI was selected as a “museum intern” in order to work on NASA-related exhibits and programming. 🌟 **Professional Development Travel Grants:** The Museum Director, Outreach Krupowicz Planetarium Coordinator/NASA JPL Solar System Ambassador and Educational Curator traveled to NASA-KSC and astronaut hall of fame in order to develop new content for the museum and educator workshops.

## PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

- **Diversity:** We increased the diversity in our program again through active recruitment and initiating new programs. Of the 18 fellowship and scholarship awards, 44% were women and 33% were from underrepresented groups, significantly exceeding our target (40% and 10%, respectively).
- **Minority-Serving Institution Collaborations:** Because RI does not have a Minority-Serving Institution of higher learning, we partner with MS (Tougaloo College) by bringing students on campus for mentored research. We also engaged a student from a MT tribal college through a 3-week course on using 3D printing.
- **NASA Education Priorities:**
  - *Authentic, hands-on student experiences in science and engineering disciplines:* All Fellows/Scholars are engaged in hands-on research directly related to NASA-relevant research; offer or support programs that directly engage students in hands-on activities through the classroom (e.g., RISD’s *Design for eXtreme Environments* class, *iGEM* at Brown), competitions (e.g., NASA Marshal Rover competition, CubeSat Opportunities), field experiences, and NASA Center engagement.
  - *Engage middle school teachers in hands-on curriculum enhancement capabilities through exposure to NASA scientific and technical expertise:* Awarded an effort to engage sixth-graders (middle school) in basic computer applications at a public charter school in an under-served city in RI (~80% Hispanic, 18% African-American). Our award helped to leverage a new *Verizon Innovate Learning Grant* (for \$20K).

- *Summer opportunities for secondary students on college campuses:* Two students developed and presented an on-campus one-week course for (juniors and seniors focusing astrobiology (“Habitable Worlds: Possible Places for Life in the Solar System and Beyond”) and was awarded 2<sup>nd</sup> place among all summer programs at Brown.
- *Community Colleges:* Met several times to discuss CC Competition but level of requirements, and need to generate and manage the precluded submission.
- *Aeronautics research:* We provided a seed grant to a researcher who is developing new tools to assess numerical solutions to super-ellipsoids in order to test the Robin boundary condition for the shape of the super-ellipsoid with an application to computations of the engine nacelles.
- *Environmental Science and Global Climate Change:* the Creation of a new permanent exhibit at the MNH (RI) exploring the earth and its climate, including NASA’s role.
- *Enhance the capacity of institutions to support innovative research infrastructure activities to enable early career faculty to focus their research toward NASA priorities:* We awarded 4 small seed grants. Two grants introduced early-career faculty to innovative research, including the effect of microgravity on cells and a new numerical solution intending to simplify computations of turbulence.

## IMPROVEMENTS MADE IN THE PAST YEAR

There were no major adjustments this last year.

## PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

**Brown University** (*Lead*): A private university with undergraduate and graduate degree programs including NASA programs. **Bryant University** (*Affiliate*): Private university known for its business programs. Provide UG and G scholarships and research awards to faculty. **Community College of Rhode Island** (*Affiliate*): Community college providing opportunities for re-training and a stepping-stone to a four-year institution (including *URI & Brown*). **Graduate School of Oceanography** (*Affiliate*): Part of the state-supported *University of Rhode Island* system (Narragansett Bay campus) exclusively for graduate studies and research on oceanography. They are the *Sea Grant* Lead for the state. NASA research includes remote sensing, astrobiology and climate. **Providence College** (*Affiliate*): 4-year Roman Catholic liberal arts college (Dominican Friars) and recipient of student and faculty awards. **Rhode Island College** (*Affiliate*): Training institution for teachers in the RI and houses the NASA’s *Educator Resource Center* (scholarship competitions). **Rhode Island School of Design** (*Affiliate*): nationally ranked private college in the arts and design and very active of the consortium through innovative curricula linking industrial design classes with NASA centers (*JSC, KSC*). **Museum of Natural History and Cormack Planetarium** (*Affiliate*): Takes the lead in most NASA-related secondary school and informal education programming. **Roger Williams University** (*Affiliate*): a private institution (Public Administration, Architecture, Law, Criminal Justice) with programs in environmental and applied math (recipient of student and faculty research awards). **Salve Regina University** (*Affiliate*): Catholic University offering PhD in the humanities offering a number of programs in the STEM fields (recipient of student research awards). **University of Rhode Island** (*URI, Affiliate*): State-supported institution and a *Land Grant* institution with relevant NASA graduate



programs (recipient of faculty & student research awards). **Wheaton College** (*Affiliate*): Private liberal arts college with faculty engaged in NASA-related research in astronomy and satellites of the outer planets (recipient of faculty & student awards). **Northeast Planetary Data Center** (*Partner, Brown*): funded through NASA's Planetary Geology and Geophysics Program and an active *Partner* through cooperative programs (exhibits) and access to planetary image data. **Ladd Observatory** (*Partner, Brown*): provides notices on topics related to astronomy as well as lectures and special events. **Krupowicz Planetarium** (*Partner*): Located at one of the schools within the Middletown Public School System, the *MNH* uses it as an outlet for informal education and educator workshops on other side of Narragansett Bay.